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MISA

Municipal/Industrial Strategy for Abatement

ECONOMIC PROFILE OF THE ORGANIC CHEMICAL MANUFACTURING SECTOR

SUMMARY REPORT

Environment Ontario

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Minister

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MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT (MISA)

ECONOMIC PROFILE OF THE ORGANIC CHEMICAL MANUFACTURING SECTOR

SUMMARY REPORT

Socio-Economic Section
Policy and Planning Branch

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ABSTRACT

- The organic chemical manufacturing (OCM) sector consists of firms involved in the manufacture and/or processing of petrochemicals, organic and specialty chemicals, and finished products.

- Most organic chemical products are derived from crude oil and natural gas. A small proportion of products can be derived from animal fats, vegetable oils and other natural materials.

- Chemical manufacturing ranks fifth in Canada in terms of value of shipments.

- About 70 firms operate 150 chemical production plants in Canada. Of these, about 60 plants or 40% are located in Ontario. The next largest centres of activity are Québec and Alberta. In Ontario, 19 of these plants, owned by 17 firms (prior to the Nova purchase of Polysar) are direct effluent dischargers subject to MISA regulations.

- Firms in the Canadian and Ontario OCM sector are generally:

  - net exporters of bulk petrochemicals. Canada is a net importer of organic and specialty chemicals.

  - price takers, with benchmark prices set internationally, primarily by American producers; and

  - capital intensive, which limits exit as well as entry

- Within Ontario, while the upstream petrochemical sector tends to be oligopolistic (few sellers) and physically interdependent, in a global context, primary and intermediate bulk chemicals are sold in highly competitive markets. The mechanism of price-setting is largely through the most mobile chemicals in the chain of commodity chemicals (i.e., polyethylene resin, or ethylene glycol), which sets the price that a consumer of ethylene can pay in Ontario.

- Producers of organic and specialty chemicals, downstream petrochemicals, and finished products operate in local markets and have enjoyed tariff protection in the past. The competitive nature of these markets may vary.

For example, a specialty chemical may find itself in a less competitive market when the product satisfies a special niche.

- The business cycle, with attendant consumer demand, is currently at a peak. The 1987/88 demand for organic chemicals grew, causing many firms to experience profits in their chemicals divisions for the first time in many years. Some firms, like DuPont, have been experiencing profits since 1981. Fixed capital expenditures, gross investment and gross fixed assets are generally increasing across the OCM sector.

- In the medium term, many firms such as Polysar are planning to increase capacity to take advantage of rising demand for chemical products.

- The industry outlook is also positive. Relatively low feedstock prices and the Free Trade Agreement (FTA) are expected to increase the competitiveness of Canadian petrochemical sector firms. The FTA may impact greatly on the organic and specialty chemical sector, and some industry representatives are of the opinion that this would induce a series of rationalizations and specializations.

- Ontario's organic chemical sector plants have exhibited basic compliance with provincial environmental objectives. The MISA program will require plant and pipe-specific monitoring for a wide variety of chemical contaminants.

1.0 INTRODUCTION

1.1 The MISA Program

The Municipal-Industrial Strategy for Abatement (MISA) is a major initiative of the Ontario Ministry of the Environment. It is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways" (Ontario, Ministry of the Environment, June 1986:7). The MISA program will encompass approximately 200 industrial establishments in Ontario which discharge wastewaters directly into provincial waterways. In addition, about 400 municipal sewage treatment plants which receive wastewaters from nearly 12,000 industrial plants could be subject to tighter controls under the MISA program.

As described in the "White Paper" (Ontario, Ministry of the Environment, 1986), the MISA program includes:

1. Development of regulations which will specify monitoring requirements;

2. Development of regulations which will specify effluent limits that are based on best available technology economically achievable (BATEA) or on water quality impacts, whichever is more stringent;

3. Implementation of enforcement activities to ensure that specific monitoring and effluent limits are implemented according to program schedules.

Further details on the MISA program can be found in the "White Paper".

1.2 Objectives and Purpose of the Summary Report

The monitoring and abatement requirements that may result from the MISA program will likely be costly to achieve and may divert money and effort from other beneficial uses by government and private industry. Consequently, in recognition of these potential costs, a comprehensive economic assessment program has been initiated to generate an economic database which can be used to develop estimates of costs and their impacts on various sectors affected by MISA.

The present report is intended to summarize the key features of the organic chemical manufacturing (OCM) sector in Canada and in particular, Ontario. It is, in part, derived from the organic chemical manufacturing sector profile prepared by A.R.A Consultants (ARA, 1988), but is further enhanced by additional data, comments and suggestions by various government and industry reviewers. The present report is not intended to show or assess the costs of compliance associated with MISA.

It should be stressed that in the context of this report, "sector" refers to that portion of industrial activity related to organic chemical manufacturing. The MISA-defined OCM sector forms a subset of this broader "sector".

The purpose of the industrial profiles is threefold:

1. Provide background information on the financial and physical dimensions of the sector and of the key firms within the sector.

2. Assess the competitiveness (i.e., how well the sector can compete) of the sector in global and domestic contexts.

3. Identify and assess factors which may have a bearing on the future outlook and long-term viability of the sector.

1.3 Data Limitations

The aggregate industrial statistics presented in this report primarily concern firms and plants whose standard industrial classifications (SIC) codes are 373 (plastic and synthetic resins) and 3783 (organic industrial chemicals). The OCM sector, as defined for purposes of the MISA program, includes four plants which are in SIC 183 (broad knitted fabric), for synthetic textile manufactures. Consequently, insights and generalizations about the organic chemical industry presented in this report do not necessarily apply to these four textile companies.

Furthermore, data tend to be limited because:

- highly aggregated company financial statements do not provide plant-specific financial data; and

. it is often difficult to separate organic from inorganic statistics.

These limitations do not prevent the development of an overview profile of the OCM sector in Canada and Ontario, but data have been obtained for only a few of the specific Ontario plants in the OCM sector as defined for the MISA program.

1.4 Report Outline

Section 2 defines and describes the organic chemical industry and its products. The industry is then placed in the Canadian context and its contribution to GNP is discussed. Section 3 reviews and analyzes sector characteristics in terms of the factors that influence its global and domestic performances.

Section 4 looks at trends associated with selected economic indicators and discusses the potential impacts of recent policy initiatives such as the free trade agreement. Section 5 provides a brief overview of the financial performance of some of the OCM sector firms listed as direct dischargers to waterways under MISA. Section 6 summarizes the environmental status of the sector and Section 7 presents a brief summary and conclusions.

2.0 SECTOR DESCRIPTION

2.1 Products

The chemical manufacturing industry consists of two broad sectors: organic and inorganic chemicals. This report deals with the organic chemical manufacturing sector.

"Organic chemicals" are compounds whose primary constituent is carbon and which are originally derived from living matter. At the present time, the vast majority of organic chemical products are derived from two fossil hydrocarbons: crude oil and natural gas. The remaining small proportion of organic chemical products are made from animal fats, vegetable oils, plants, and other natural materials.

There are basically three categories of organic chemicals of interest:

1. Petrochemicals, which consist of:

   - Primary petrochemicals, which are derived directly from natural gas or petroleum. The feedstocks for these chemicals tend to be outputs of petroleum refineries and natural gas processing plants. Primary petrochemicals represent important building blocks for the organic chemical manufacturing sector. Examples are aromatics (benzene, toluene, xylene), ethylene and propylene. Most primary petrochemicals are processed further to make intermediate petrochemicals.

   - Intermediate petrochemicals are the products of the processing of primary petrochemicals. For example, ethylene is processed to make ethylene dichloride which in turn is used to make vinyl chloride. Vinyl chloride can be polymerized to polyvinyl chloride (PVC) which is used for a wide variety of end products such as sewer pipes, plumbing and house siding.

2. Organic and specialty chemicals, which are used by secondary manufacturing industries in the production of consumer products such as cosmetics, pharmaceuticals and detergents. These specialty chemicals are characterized by

batch type, small scale, and high cost operations. A large proportion of Canadian demand for special chemicals is met by imports.

Petrochemicals and organic and specialty chemicals are then used to produce:

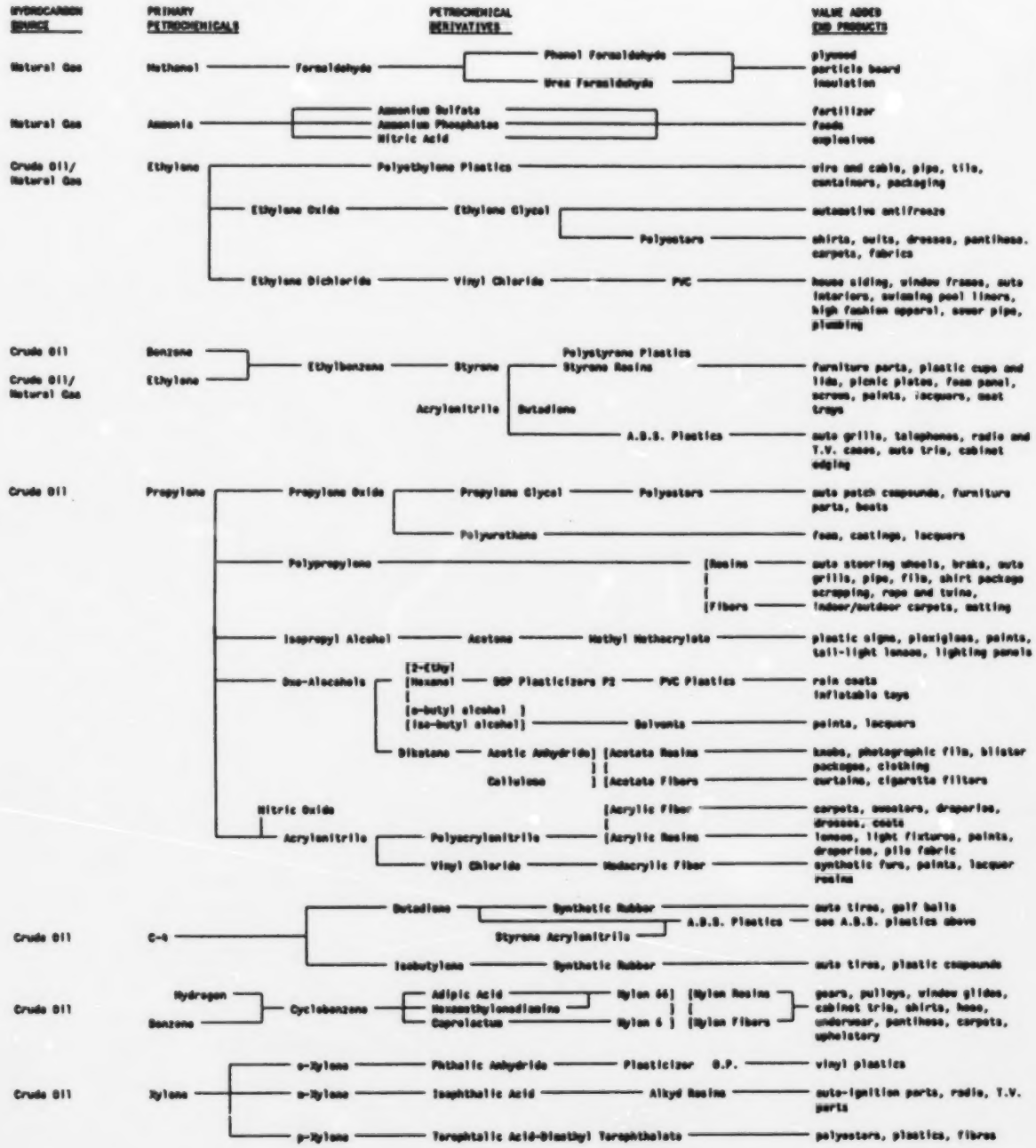
3. Finished products, which consist mainly of plastic resins and organic material which may still require further processing to be used in industrial and consumer applications.

Figures 1 and 2 outline the processes which convert source hydrocarbons into intermediate and final products for the petrochemical and specialty chemical sectors respectively. As shown in Figure 2, the petrochemical industry provides the bulk of inputs for the specialty chemical production processes. The petrochemical industry represents the major portion of the organic chemical manufacturing sector.

In Canada, about 6% of crude oil and 25% natural gas consumption is used by the chemical industry. The feedstocks for the chemical industry are separated from the crude oil or natural gas as it is processed through refineries or gas processing plants. These "feedstocks" are broken down ("cracked") in petrochemical plants and then recombined ("polymerized") to form new products. In other words, less valuable petroleum or natural gas compounds are chemically altered into those which have greater market demand, and hence value.

In reviewing the organic chemical industry, certain decisions regarding the scope of the sector were made. Excluded from sector statistics are products that are made from organic products but have not been chemically altered (e.g., knitting pantyhose from nylon yarn) and domestic fertilizer production (i.e., amonia based products). A further assumption was made with respect to Statistics Canada data. Just over 70% of SIC 3712 (organic chemicals) plus SIC 373 (plastics and synthetic resins) data represent petrochemical data and are therefore used, where possible, to quantify representative trends in the OCM sector.

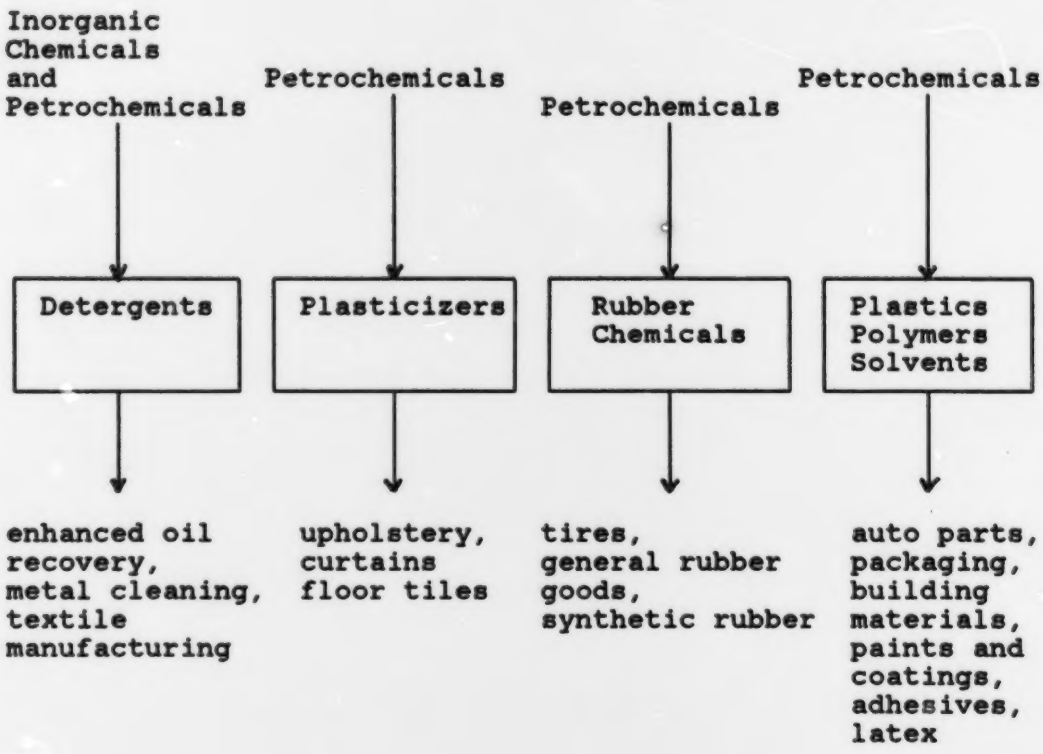
Figure 1
Petrochemical Sources to End-Use Applications



Source: CCPA, et al.

FIGURE 2

PRODUCTION AND USES OF SELECT ORGANIC AND SPECIALTY CHEMICALS



Source: CCPA, Overview of the Canadian Manufacturing Industry, Spring 1987; OCM Industry Reviewers

2.2 The Organic Chemical Manufacturing Sector in Canada

Approximately 70 firms own and operate about 150 chemical production plants and other establishments throughout Canada. Of these, some 54 companies operate about 60 plants in Ontario. The majority of the remaining plants are located in Québec, followed by Alberta. These three provinces account for over 90% of the value of shipments from Canadian plants. Firms within the petrochemical sector tend to be large multinationals, the majority of which are foreign-owned. Polysar and Novacor Chemicals Limited are large, Canadian-owned firms which now form part of Nova Corporation of Alberta. Dow is 100% U.S. owned and DuPont is 73% U.S. owned. (DRIE, 1988).

Only 19 of the Ontario plants, owned by 17 firms (prior to the Nova purchase of Polysar), are direct effluent dischargers and will be subject to the MISA monitoring and abatement regulations. Table 1 lists these 19 plants, their location in Ontario, and their major products. As noted, the products of four of these plants are not technically organic chemicals and so do not compete with the products of the other producers in the OCM sector. Data on the financial performance of most of the firms that own these plants are presented in Section 5 of this report.

The Canadian chemical manufacturing industry (organic plus inorganic sectors) is in the top five industrial sectors in Canada. The petrochemical industry represents over 60% of the Canadian chemical manufacturing industry. Canadian petrochemical, organic and specialty chemical firms sold over $5.0 billion worth of products in 1986, up over 2% from the previous year. Of this amount, 62% were sold in Canada. The petrochemical, organic and specialty chamical sector owned over $7.3 billion worth of gross fixed assets in 1986 (CCPA, 1986).

Value added by the organic chemical sector in 1986 was $2.2 billion, with petrochemicals alone representing 87% ($1.9 billion) of total value added. Raw material purchases in 1986 amounted to $3.4 billion (CCPA, 1986).

Petrochemicals have been a growing Canadian chemical sector in recent years. End product sales have increased by an average of 2.2% annually.

TABLE 1

ONTARIO OCM SECTOR FIRMS SUBJECT TO MISA MONITORING REQUIREMENTS

COMPANY	PLANT LOCATION	PRODUCT
B.F. Goodrich Canada Inc.	Thorold	polyvinyl chloride (PVC), PVC/polyvinyl acetate
BTL Industries Inc.	Belleville	phenol-formaldehyde resins, *formaldehyde, *hexamethylene tetramine
Borg-Warner Chemicals Ltd.	Cobourg	acrylonitrile-butadiene-styrene (ABS) resins, ABS intermediate latex
CanadianOxy Chemicals Ltd.	Fort Erie	phenol-formaldehyde resins
Celanese Canada Inc.	Millhaven	polyester staple/tire yarn
Cornwall Chemicals (CIL) Limited	Cornwall	carbon disulphide, carbon tetrachloride
Courtaulds Fibres Canada	Cornwall	viscose, rayon from pulp
Courtaulds Films	Cornwall	cellulose film from viscose
Domtar Chemicals Inc.	Longford Mills	synthetic detergent base
Dow Chemical Canada	Sarnia	VCM, chlorinated solvents, propylene oxide, propylene glycols, chlorine, caustic soda, styrene, polystyrene, latex, epoxy resins, ethylbenzene, HDPE/LDPE, hydrochloric acid, polyglycols, propylene oxide
DuPont Canada Inc.	Maitland	adipic acid*, hexamethylene diamine*, HCl, hydrogen peroxide, chlorofluorocarbons, engineering resins, spandex yarn, dibasic acids, hydrogen*

TABLE 1 (Continued)

COMPANY	PLANT LOCATION	PRODUCT
DuPont Canada Inc.	Kingston	nylon yarn/staple/flake
DuPont Canada Inc.	Corunna	HDPE/LLDPE
Esso Chemicals Canada Ltd.	Sarnia	PVC, HDPE, LDPE, naphthas, lube oil additives, C5-C15 olefins, ethylene/propylene*, aromatics (benzene, toluene, xylene)
Ethyl Canada Inc.	Corunna	TEL, TML, ethyl chloride, diesel ignition improvers, aluminum alkyls
Novacor Chemicals (Union Carbide)	Mooretown	LDPE/HDPE
Polysar Limited (now owned by Nova Corporation of Alberta)	Sarnia	latex**, halobutyl and butyl rubbers, NBR, SBR, polybutadiene, styrene, ethylbenzene*, ethylene, aromatics, butadiene*, butylenes, acetylene*
Rohm and Haas Canada Inc.	Morrisburg	polymethylmethacrylate sheet, oil additives
Uniroyal Chemicals Limited	Elmira	rubber chemicals, liquid urethanes, agricultural chemicals for seed treatment, specialty chem-antioxidants/stabilizers, water treatment chemicals, nonyl phenol

* Captive Use (in-plant use only).

** Polysar sold its latex business and plants to BASF.

Source: MOE, Water Resources Branch, 1988; OCM Industry Reviewers

Legend:
- PVC - polyvinyl chloride
- VCM - vinyl chloride monomer
- HDPE - high density polyethylene
- LDPE - low density polyethylene
- LLDPE - linear low density polyethylene
- HCl - hydrochloric acid
- TEL - tetraethyl lead
- TML - tetramethyl lead
- NBR - nitrile-butadiene rubber
- SBR - styrene-butadiene rubber

As shown in Figures 3a and 3b, Canada enjoyed a positive trade balance for 6 out of the past 10 years. However, despite the fact that exports accounted for over 40% of the industry's output in 1986, a negative trade balance of $82 million was realized. On the other hand, most of Canadian demand for organic and specialty chemicals is met through imports. Figures 4a and 4b show an increasing level of imports each year for the past 10. Moreover, the trade deficit has grown steadily totalling $1.7 billion in 1986. Together, petro and organic chemicals posted a negative balance of trade of $1.8 billion during 1986.

For firms like Dow and Celanese, integration with a foreign (usually U.S.) parent is important as they sell their products in export markets through their U.S. corporate operations.

Figures 3b and 4b clearly show that Canada is a primary producer of commodity chemicals for the export market with growth in demand for organic and specialty chemicals being met largely by imports.

The organic chemical industry employed just over 17,000 people in all of Canada during 1986. While this is not large in terms of direct employment, the industry tends to generate substantial indirect employment. For example, CCPA figures indicate that if ethane extraction represents 1 job, then the following Canada-wide employment multipliers would apply (CCPA, Spring 1987):

. ethane extraction	- 1 job
. ethylene manufacture	- 4 jobs
. first derivative	- 118 jobs
. second derivative	- 351 jobs
. third derivative	- over 6000 jobs

Table 2 provides five years of selected Canadian aggregate organic chemical industry statistics for CCPA member firms. These indicate that the organic chemical industry is recovering from the recession in the early 1980s.

Table 2 reveals that while fixed capital expenditures were declining during the recession years of 1982/83, gross investment, gross fixed assets and even total sales were rising, albeit at lower rates. Debt loads, increasing over the recessionary period, have begun to be reduced slowly, decreasing by 1.9% in 1985, and 1.1% in 1986. As noted above, current trends indicate recovery and future growth in petrochemicals, however, the recovery comes on top of a period of losses for the years 1982 to 1986 inclusive.

Figure 3a

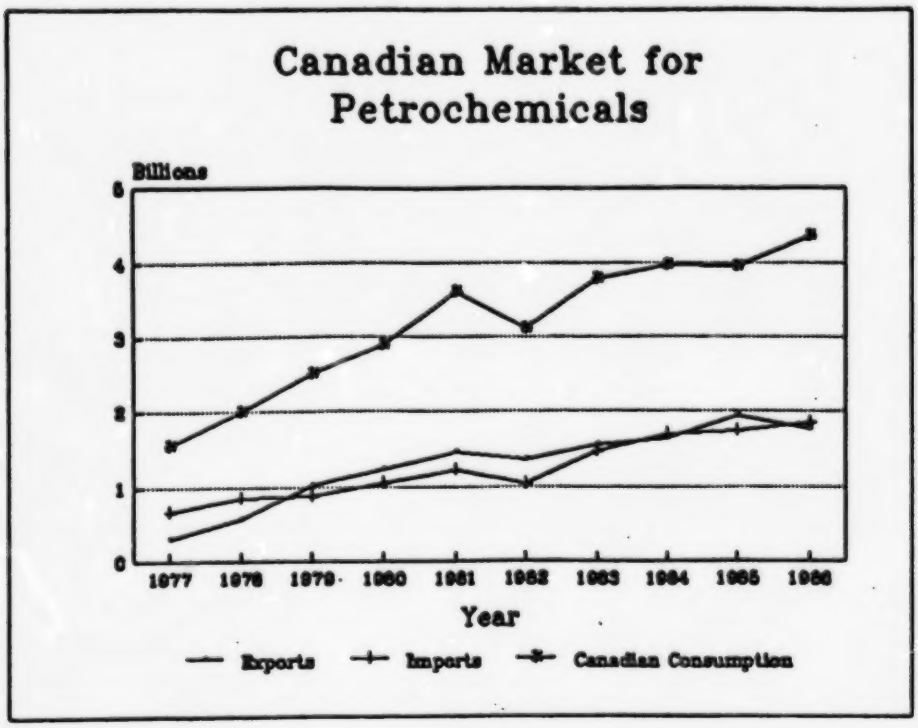
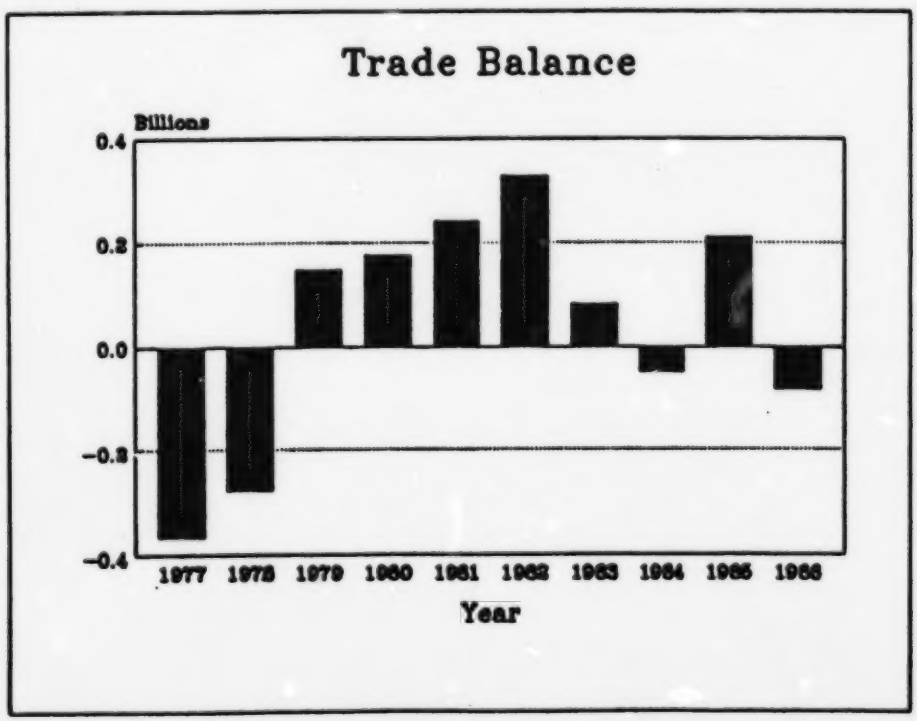


Figure 3b



Source: CCPA, Fact Book Updates, 1986

Figure 4a

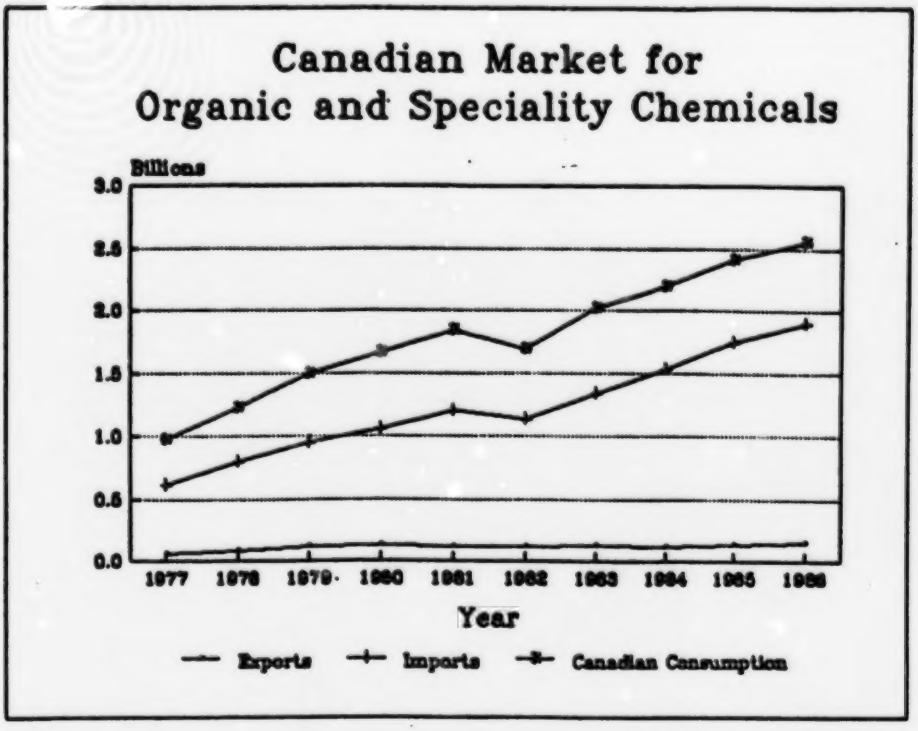
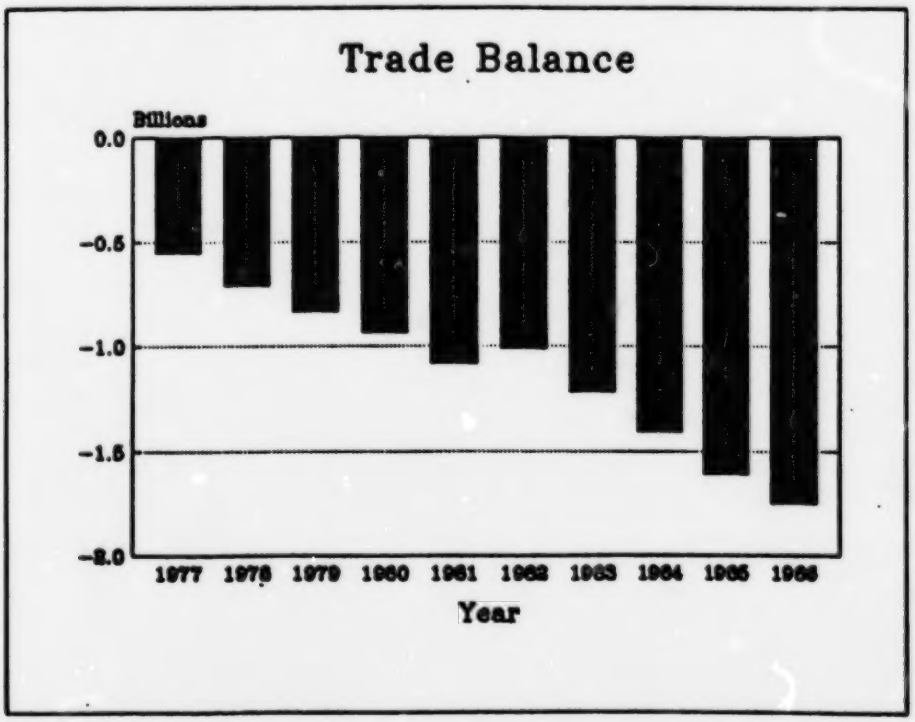


Figure 4b



Source: CCPA, Fact Book Updates, 1986

TABLE 2

ORGANIC CHEMICAL MANUFACTURING SECTOR STATISTICS, 1982-1986

($ MILLIONS)

	1982	1983	1984	1985	1986
Fixed Capital Expenditures	1270	775	383	256	313
Gross Investment	7833	8253	8866	8822	8944
Gross Fixed Assets	6245	6592	7137	7040	7323
Long and Short-Term Debt*	3049	3196	3588	3520	3480
Total Sales (end products only)	4126	4673	4716	4973	5091
Canadian Production to Canadian Market	2636	2992	2947	2891	3170
Total Exports	1490	1681	1769	2082	1921
Balance of Trade	(686)	(1135)	(1453)	(1399)	(1828)
Total Employment (#)	18940	17926	17692	17568	17101
Total Pay	585	592	616	647	690
Profit (before interest, taxes, special write-offs)	46	118	309	(47)	345
Taxes (current and deferred, after write-offs)	13	44	104	(178)	114
Value Added	1627	1621	1900	1871	2177
Net Profit (after-taxes)*	(129)	(124)	(132)	(520)	(173)

*Petrochemical Sector

Source: CCPA, Fact Book Updates, 1986 (Statistics based on CCPA Petrochemical and Organic and Specialty Chemical Sector member firms).

A discussion of the competitive factors characterizing the organic chemical sector follows in Section 3. Sector trends are analyzed in Section 4.

Since plant-specific data are not always available, an understanding of the products and markets in which the Ontario firms subject to the MISA regulations operate must be used to provide a more qualitative financial impact evaluation. This is presented in Section 5.

3.0 SECTOR CHARACTERISTICS

The organic chemical manufacturing (OCM) sector is characterized by several major elements which are discussed in this section.

As seen in Figure 1, ethylene is the most important building block in the entire industry. Ethylene can be produced from a variety of feedstocks. In Alberta, ethylene (and its derivatives) is derived from ethane, which is extracted from natural gas in a series of "straddle" plants. These plants are so named because they straddle the main natural gas transmission lines in Alberta. A variety of firms have an interest in these straddle plants, principally Dome, NOVA (which also runs the pipelines), and a number of producers. The straddle plants and NOVA's ethylene plants are collectively known as "the Project".

The Project originally had complete control over essentially all ethane recovered in Alberta. NOVA bought the ethane from the straddle plants at the Alberta Border Price for natural gas which, at that time, was regulated. Most of the ethane was used by Alberta Gas Ethylene (AGE), a NOVA subsidiary to make ethylene. The remainder was sold to producers who reinjected it into oil wells for enhanced oil recovery purposes or exported to a U.S. utility for power generation purposes (Alberta prohibited its export for use as a petrochemical feedstock). AGE sells ethylene at a cost of service basis.

Today, producers want the right to extract ethane in the field. If they do so, they will bypass the straddle plants, whose input gas will be lowered as a result. On the other hand, the producers claim that new ethane will be recovered that is currently consumed as fuel in Alberta. The Alberta Government asked the Alberta Energy Resources Conservation Board (AERCB) to examine the issue. Their report recommended (not decided) that the Project's entitlement to ethane be limited to the requirements of the existing AGE ethylene plant. The existing AGE plants would still have access to ethane at cost of service prices, but the feedstock needed for future expansions would have to be purchased on the open market.

Alberta has now decided on an ethane policy which allows natural gas producers to extract ethane at field-stripping plants and sell the product to enhanced oil-recovery projects or to petrochemical producers. The Alberta government also ruled that a minimum volume must be maintained at the straddle plants for the use of existing companies. Under this new policy, Alberta will

collect an ethane royalty and sell petrochemical producers 7,500 barrels a day each of ethane to encourage new plants (Globe, 88/10/19). Currently, both Nova and Dow have announced intentions of building new ethylene plants in Alberta.

Ontario's petrochemical producers, however, do not need to rely on Alberta for their ethylene supplies though at least Polysar's feedstocks originate from there. While AGE produces from ethane about 60% of the ethylene made in Canada, Esso Chemical and Polysar in Ontario account for about 30% of Canadian production. A plant in Quebec generates the remaining 10%. Most of these suppliers do not use ethane as a feedstock, but instead use propane, butane, condensates and crude oil fractions, none of which are controlled by Alberta. Only about 10-15% of AGE ethylene production moves to Ontario.

Chemical producers in Ontario and Canada tend to be price takers in a global context because market prices for petrochemical commodities, including ethylene, are set in international markets. One exception to this is in Alberta, where ethane and ethylene are supplied on a cost of service basis to Alberta users. Organic chemical producers located along the Gulf Coast of Louisiana and Texas are price leaders, whose prices are increasingly seen as world benchmark prices for petrochemical products. The price paid by Ontario's petrochemical producers for resale ethylene from Alberta is constrained by Gulf Coast prices whose products could soon be sent into Ontario and Quebec if Albert prices become high enough.

The U.S. producers are price setters because of the scale of their plants which are justified by the size of their market. They also enjoy several advantages over other world producers, including Canada. These advantages include (Task Force, 1984):

- lower construction labour costs
- *in situ* and vertically integrated production infrastructures (feedstock pipelines, services, utilities)
- feedstock flexibility (ability to process a variety of feedstocks rather than being dependent on one feedstock)
- economies of scale
- lower operating costs
- greater experience
- skilled labour force

However, it should be noted that the large facilities in Sarnia and Alberta are integrated, have adequate feedstock flexibility, are world scale size, and have competitive operating experience and skilled labour.

Organizations such as Nova (including Polysar), Esso, and Dow are prime examples.

Canadian chemical producers have experienced low (below 70%) capacity utilization rates during the years 1980 to 1985 as shown in Table 3. These conditions further constrain Canadian companies to be price takers.

Canada has tried to protect its chemical industry with tariff and non-tariff barriers, with rates generally increasing as the product is upgraded. Examples of rates for selected petrochemicals are shown in Table 4.

Table 4

Tariffs on Selected Canadian Produced Petrochemicals

January 1, 1988

	Canada	U.S.	EC.	Japan
Primary				
Ethylene	Free	Free	Free	5.8%
Intermediates				
Styrene	7.5%	7.4%	6%	6.4%
Ethylene dichloride	10%	1.3¢/kg +3%	12%	5.8%
Ethylene glycol	10%	12%	13%	9.6%
Polyethylene	10.2%	12.5%	12.5%	22.4 yen/kg

Source: DRIE (1988)

The Canada-U.S. Free Trade Agreement (FTA) will eliminate tariffs of significance to petrochemicals over five equal annual reductions beginning January 1, 1989.

Canada has been moving towards becoming a world player in the organic chemical market. As noted, Ontario producers, particularly those located in Sarnia's "chemical valley" have developed the flexibility to utilize different feedstocks in order to eliminate this historical disadvantage relative to American Gulf Coast producers. This capability is giving Ontario's producers a unique advantage in the domestic and export markets.

Feedstocks for ethylene production are essentially by-products of natural gas or crude oil production, making the ability of producers to utilize a range of feedstocks is a great advantage. Natural gas liquids

TABLE 3

CANADIAN CHEMICAL

CAPACITY UTILIZATION RATES*, 1976-1986

1976	76.7
1977	74.7
1978	75.7
1979	75.4
1980	67.4
1981	69.3
1982	57.0
1983	63.4
1984	67.9
1985	70.9
1986	72.4

Source: StatsCan 31-003, Chemicals and Chemical Products (annual averages)

*Note: StatsCan tends to underestimate utilization rates since its definition adjusts for general prices levels rather than specific prices levels. The above statistics are not an engineering measurement of capacity utilization.

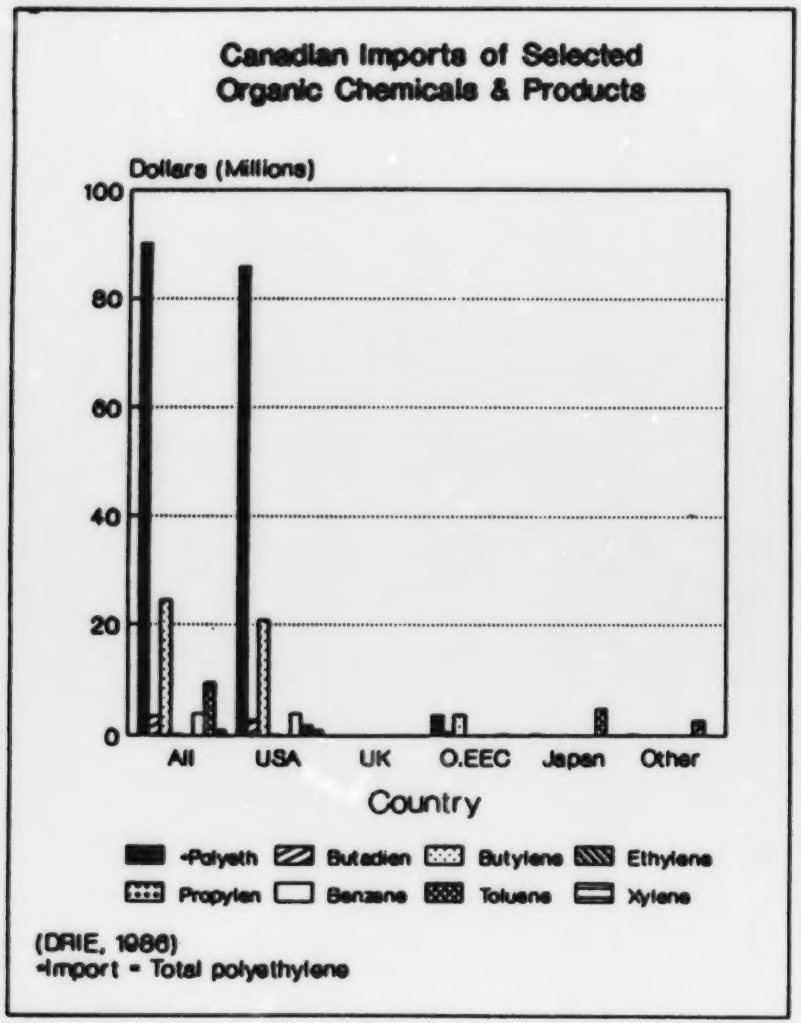
(NGLs), from which ethylene is made, are by-products of natural gas production. Consequently, their supply is therefore inelastic with respect to price. The OCM sector must compete with other sectors for supplies of raw materials.

The organic chemical manufacturing sector is very sensitive to the business cycle. The recession in the early 1980's resulted in depressed demand, falling prices, and losses by a number of firms. Canadian producers cannot easily make adjustments in response to changing supply and demand pressures because of high capital costs associated with building world scale plants. The large investment needed to capture fully economies of scale represents a barrier to firms wishing to exit as well as enter the industry. Therefore, although Table 3 indicates that there is excess capacity in the Canadian chemical industry, capacity rates alone are not always a clear indicator of the state of this sector. Currently, the market expanding and the business cycle may be peaking. Producers are seeking to expand capacity to meet rising demand.

A basic characteristic of this sector is its global nature. Canadian and Ontario firms, seek to access world markets through product exports. The data in Figures 5 and 6 show the 1986 level of Canadian imports and exports of selected organic chemicals and products. Canada's largest trading partner is the United States. The U.S. accounts for over 60% of Canada's exports and over 90% of imports in the chemicals noted. These organic chemicals are used because they represent the more import primary petrochemical building blocks (see also Figure 1). In terms of world supply, however, Canada is still a small, but growing, player. At present, Canadian exports are not large enough to influence world prices.

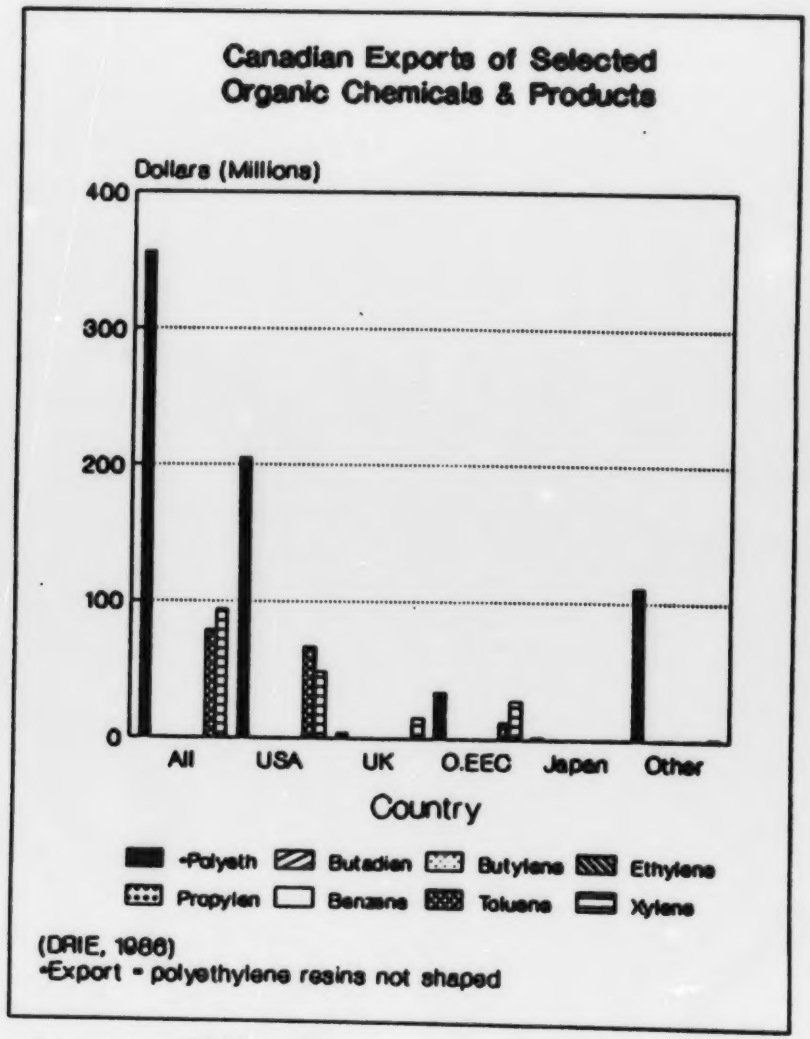
Within Canada, the organic chemical manufacturing sector varies. As noted, Ontario tends to be the hub of activity and has developed necessary feedstock flexibility and infrastructures for its basic petrochemical production. Eastern (Maritime) Canadian producers tend to rely on crude oil derived feedstocks. During the period of rapidly rising oil prices in the 1970's, these producers were unable to absorb the resulting high feedstock costs even though Canadian producers were protected from even higher world oil prices. The result was a shutdown of oil refinery capacity. Québec (Montréal) petrochemcial producers, who also tend to be dependent on oil refinery outputs also suffered declines. The Petromont plant in Montreal has now installed the flexibility to process a range of feedstocks, but is having difficulty obtaining NGLs at attractive prices. Currently, there is little overlap

Figure 5



Source: DRIE, 1986

Figure 6



Source: DRIE, 1986

between the markets served by Ontario and Québec producers. This may change if Québec goes ahead with expansion plans.

Another feature of the petrochemical sector is the level of interdependence among the firms involved. The sector as a whole tends to be oligopolistic. That is, a relatively small number of firms account for a large proportion of the output especially in upstream, primary petrochemical sector. A degree of interdependence of these firms is an essential feature of oligopolies. An example of this is the interdependence of the Sarnia based organic chemical firms. As shown in Figure 7, the output of one plant is used as an input to another plant. The larger firms, such as Polysar and Dow, produce many chemicals and chemical products which are used by the firm itself. These large, vertically intergrated firms produce their own feedstocks, intermediate chemicals and eventually end products.

In Canada, a large proportion of chemical production is generated by 4 firms, who in 1984 accounted for 24% ($3.9 billion) in sales, 31% ($4.3 billion) in assets, and 26% ($1.6 billion) in equity of industry totals (ARA, 1987). Table 1 also indicates, for the nineteen MISA-defined OCM sector plants, which products are used internally.

The competitive nature of markets for downstream organic and specialty chemicals tend to vary. For example, some specialty chemicals may operate in a less competitive market when these products satisfy a special niche. Other products may have greater potential for product substitution by consumers.

In summary, the OCM industry in Canada and Ontario can be described as:

- dependent on feedstocks
- price takers, with market prices set internationally
- capital intensive
- oligopolistic in the upstream petrochemical sector
- competitive in downstream petrochemical and specialty chemical sectors

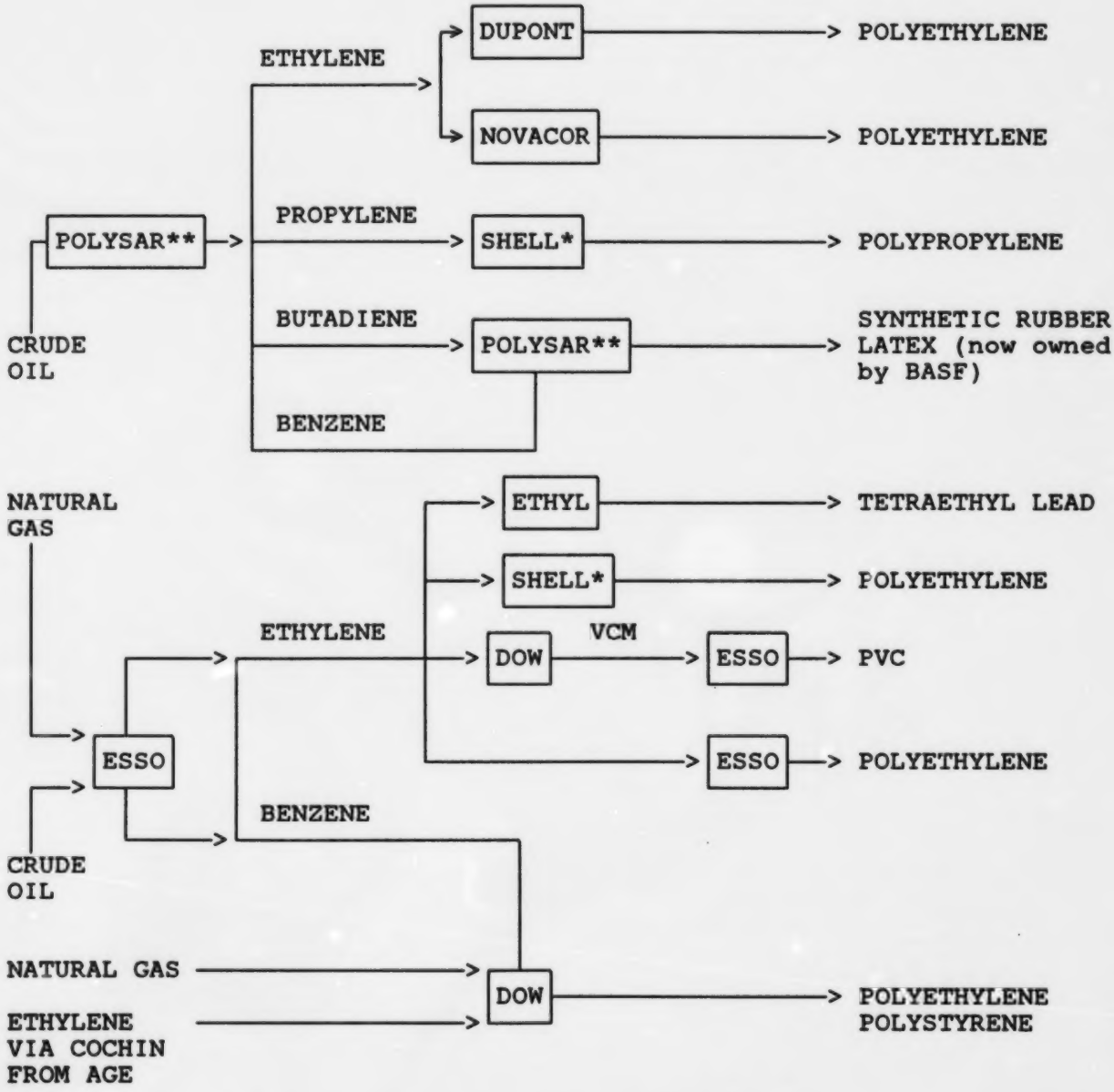
The trends and future prospects for the industry are discussed in Section 4.

FIGURE 7

SIMPLIFIED FLOWCHART OF

ONTARIO PETROCHEMICAL INDUSTRY INTERDEPENDENCE

IN SARNIA, ONTARIO



Source: Task Force on the Petrochemcial Industry, 1984

* In MISA Petroleum Refining sector.

** Polysar purchased by Nova.

4.0 SECTOR PERFORMANCE

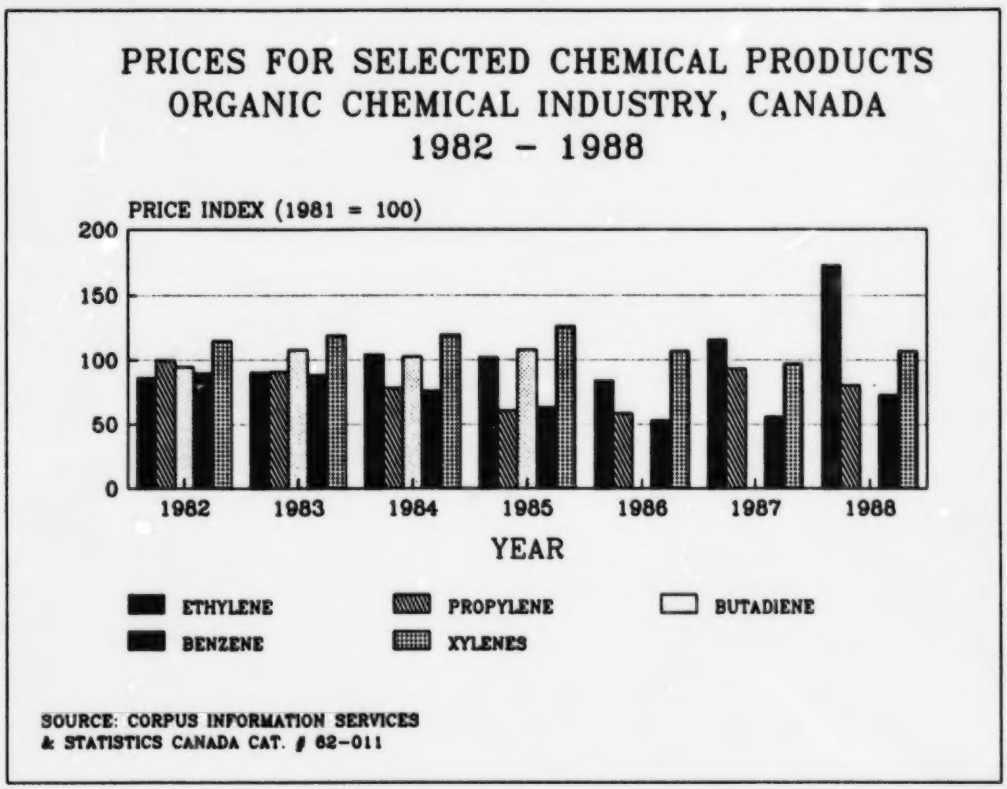
4.1 General Trends and Medium Term Outlook

In its early history, Canada's petrochemical industry consisted of relatively small scale plants. This was a difficult position to maintain, since other countries were building larger scale plants aimed at exports, especially to the U.S. To meet this competition and to capitalize on the abundant hydrocarbon resources in Canada, the Canadian petrochemical industry, beginning in the early 1970's, undertook a major expansion program and large investments in world scale plants. In 1977, a world scale plant was opened by Petrosar (a joint venture, at that time, of Polysar, DuPont and Union Carbide) in Sarnia. With the start up of AGE's (Alberta Gas Ethylene Co.) first ethylene plant in 1979, Canada's ability to produce ethylene derivatives, such as polyethylene ethylene glycol, and vinyl chloride, significantly increased.

Canadian producers experienced profits during the late 1970's due to positive economic growth and government initiatives such as the National Energy Program (NEP), which held the domestic price of oil below the world price so long as the latter was rising. When the world oil prices began to fall, Canadian oil prices rose above the world price in the early 1980's. Higher domestic oil prices pushed up feedstock costs for chemical producers in the face of continued slack demand. The recession in the early 1980's thus caused export demand, and profits, to slip. At the same time, producers still carried the high capital costs of earlier expansions.

The sector performance can also be assessed by recent price fluctuation trends of selected chemical products. As illustrated in Figure 1, certain chemical products form the more important building blocks of the industry. Figure 8 illustrates that the prices of these products tend to fluctuate. The price of ethylene is the only one that has risen fairly steadily since 1982. Other products such as xylene and propylene seem to be slowly rising in price. The price of butadiene is not available for 1986-1988 as it is not a commodity chemical and Polysar is the only Canadian producer (ARA, 1988). In May 1987, the price for benzene reached a high of $900/tonne because of strong demand and limited supply. As additional supplies became available the price dropped to a 1987 level of $330/tonne (ARA, 1988).

Figure 8


PRICES FOR SELECTED CHEMICAL PRODUCTS
ORGANIC CHEMICAL INDUSTRY, CANADA
1982 - 1988
PRICE INDEX (1981 = 100)
200
150
100
50
0
1982
1983
1984
1985
1986
1987
1988
YEAR
ETHYLENE
PROPYLENE
BUTADIENE
BENZENE
XYLENES
SOURCE: CORPUS INFORMATION SERVICES
& STATISTICS CANADA CAT. # 62-011

Prices are not an absolute sector indicator, of course, since costs are also a major parameter in determining profitability. The sector statistics shown in Table 2 also indicate positive growth in fixed capital expenditures, gross investment and gross fixed assets.

Companies are planning expansions and are currently experiencing record profits. For example, Eastman Kodak announced plans to build a plant in Toronto by 1990 with the capacity to produce 100 million pounds per year of an OCM sector product called polyethylene terephthalate (PET) used to make soft drink bottles (Globe, 88/03/25). Industry experts predict that worldwide demand for PET polymer, which was 1.7 billion pounds in 1987, will grow to 4 billion pounds by 1993. Polysar is in the process of restarting a mothballed styrene plant (expected to come on line in Q2'89) in Sarnia because of the low supply and rising demand for styrene, which is a building block in the manufacture of plastics and synthetic rubber. The price of styrene rose from 18 cents per pound in 1986 to about 45 cents per pound by mid-1988. Polysar expects the styrene plant to add at least $18 million to company petrochemical earnings (Globe, 88/03/25).

Nova experienced a profit of $179 million in 1987, and had plans to build another ethylene/ polyethylene manufacturing complex (AGE III) in Alberta in response to the rising prices for ethylene (Globe, 88/04/27). However, the Alberta government's new ethane policy could result in a $300 million scale-down in this complex (Globe, 88/10/19). There is also the possibility of an expansion in Ontario pre-empting AGE III.

In May 1988, Occidental Petroleum (Canadian Oxy's parent) purchased Cain Chemical, thereby becoming the third largest maker of ethylene (Fortune, 88/11/07). Oxy is expected to enjoy "substantial" profits from its chemical properties.

Companies are similarly optimistic in their annual reports. Shell Canada reported a strong 1987 performance from the sale of styrenes and polymers. Demand in both the domestic and export markets rose and Shell's styrene plant in Alberta operated at close to full capacity (Shell, 1987). Polysar noted, in its 1986 annual report, significant gains in the petrochemical industry. That firm has expanded its polystyrene capacity in order to provide a base for growth into the specialized plastics market (Polysar, 1986).

4.2 Future Outlook

Historically, the OCM industry has been subject to cyclical swings. Prosperous times prompt expansion of capacity. Economic downturns reduce demand which result in production cutbacks and excess capacity. However, the future of the Canadian organic chemical manufacturing sector as a whole continues to be positive. Feedstock prices, a major component of products costs, are expected to grow but remain low relative to previous levels in the 1970's. The reference price of crude oil is expected to remain under $20(U.S.) a barrel until 1994 and rise to about $31(U.S.) by 2000. Natural gas, now at about $2 per thousand cubic feet (MCF) is expected to rise to $4/MCF by 2000 in tandem with oil prices (Globe, 88/04/14&18). These long term trends are heavily dependent on OPEC pricing strategies. Short term price fluctuations will not likely have a major effect on the chemical sector (Chemical Week, 1988). Production activity can be expected to expand in order to meet rising demand and capitalize on favourable market conditions.

If the Canadian dollar continues to trade at a sub-par level relative to the U.S. dollar, it will continue to provide a production cost advantage to Canadian plants. Conversely, the gaining strength of the Canadian dollar may impact the cost of ethylene tied by a formula to U.S. Gulf Coast prices.

An example of these trends is the North American polyethylene industry. Capacity utilization is expected to rise to 90% by 1990. The capacity squeeze being exerted on polyethelene coupled with import barriers provided by weak U.S. and Canadian dollars is expected to raise the price of polyethlene (ARA, 1988). A derivative of ethylene is PVC (polyvinyl chloride) plastic used in a wide variety of consumer products such as pipes, sidings and cables. World demand for PVC is expected to grow by over 4% by 1990. In Canada, a significant increase in domestic and export demand is expected over the next five years (McCarthy, 1985). CanadianOxy is currently bringing on-line a PVC compounding plant in Ontario with an initial capacity of 10,000 tonnes per year. B.F. Goodrich has also announced, and is now building, its own expanded PVC production facility.

International competition from Saudi Arabia, Kuwait, and the Pacific Rim is expected to intensify. Saudi Arabia has built world scale and

efficient petrochemical plants to take advantage of its own feedstock supply. The rapid industrialization of the Pacific Rim countries make this area a prime export target for Canadian and Ontario producers. At the same time, the European petrochemical industry, still heavily dependent on crude oil, seems to be shifting away from bulk chemicals into the specialty chemical market (Economist, 1985).

Another major factor for the organic chemical sector is the U.S.-Canada Free Trade Agreement (FTA), which is expected to increase competition as well as Canada's access to U.S. markets. The FTA may result in the closure of certain unprofitable plants regardless of positive sector performance.

A trend of deregulation is also growing within Canada. For example, NOVA feels that its planned ethylene complex (see Section 4.1) may be jeopardized by an AERCB report recommendation not to guarantee ethane supplies to NOVA, and its policy statement that prices for future ethane should be negotiated between producers and industry without provincial interference (Globe, 88/05/04). The power of Alberta to set production quotas and prices for feedstocks may therefore be replaced with a more competitive market wherein organic chemical producers will be able to negotiate prices and quantities directly with producers of feedstocks. This may result in higher ethane prices since, as noted, Alberta ethane (like ethylene) is presently supplied to users at a cost of service price only.

5.0 FINANCIAL PERFORMANCE

The Canadian organic chemcial industry has been experiencing mixed financial results over the past 10 years. While total sales have been growing steadily, after-tax losses were experienced annually since 1982. This trend is reversing as the economy revives.

The petrochemical sector is starting to increase its capital expenditures, spending $220 million in 1985, $280 million in 1986 and anticipating a $309 million expenditure for 1987. Its debt load is slowly being reduced after reaching a peak in 1984. Profits before interest, taxes and special write-offs totalled $255 million in 1986, opposed to a loss of $129 million the year before. Exports have, on average, been rising, as has Canadian chemical consumption.

Sales of organic and specialty chemicals have remained fairly constant since 1984. Lower sales levels in 1982 and 1983 reflected the reduced demand for specialty chemicals during the recession. Profits before interest, taxes and special write-offs rose by an average of 5% per year between 1983 and 1986.

A review of company performance statistics available for those firms whose plants are subject to forthcoming MISA regulations reveals little homogeneity and large variation. A major problem in reviewing company statistics is that they tend to be highly aggregated. Most companies do not disaggregate data from plants by individual provinces or by business or product segments. Therefore, the performance ratios may characterize the financial state of the company but not its individual parts. Similarly, the financial performance indicators of the OCM companies do not necessarily represent the organic chemical industry because some firms make and sell products in a different industrial sector. Recent corporate acquisitions, such as the Nova takeover of Polysar, may also impact financial statistics. The following assessment should therefore be viewed as a general indication of the financial state of firms who operate within the OCM sector.

After-tax profit or net income (loss) equals total revenues from operations less operating costs, interest expense, depreciation, minority interest and income tax. After-tax profit over several years is a primary indicator of the health of a company and an industry. The accompanying net income data shown in Figure 9 shows increasing profit levels with major improvements in 1987. Most companies have returned to or exceeded the pre-recession net income levels.

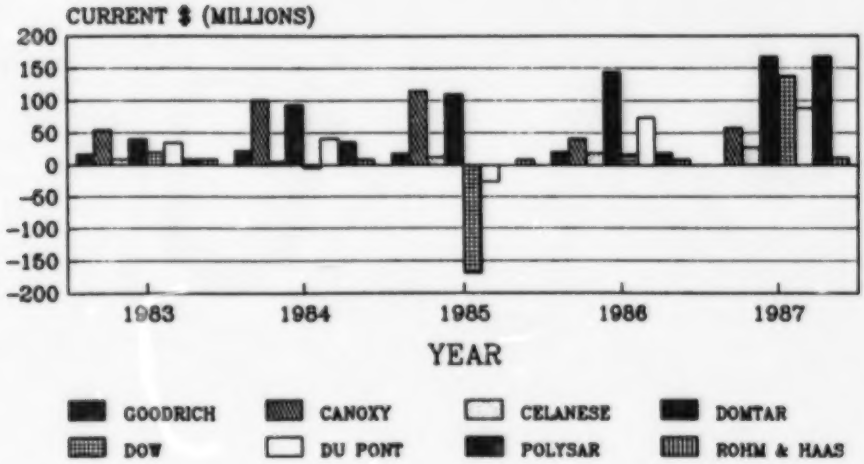
Internal cash flow is defined as net income plus depreciation. This indicator helps one to determine a company's or in industry's ability to pay dividends and finance expansion. A company which shows little after-tax profits can still meet its short term debts and obligations if cash flow is adequate. The larger the cash flow, the better. While Domtar stands out in Figure 10, most companies show steady improvement in their cash flow position.

The debt-equity ratio equals total debt divided by shareholder's equity. This ratio expresses the relationship between capital contributed by creditors and that contributed by shareholders. A lower ratio indicates greater protection for the creditors and greater borrowing flexibility. Rohm and Haas, Dow Chemical and Polysar have reported ratios over the past few years which have been constistently greater than the chemical industry average, as illustrated in Figure 11.

The rate of return on assets equals net income plus interest charges divided by total assets. This ratio is a measure of management performance and reflects how well assets have been invested. Figure 12 shows that Rohm and Haas has consistently exceeded the industry average with positive growth throughout the five year period.

Figure 9

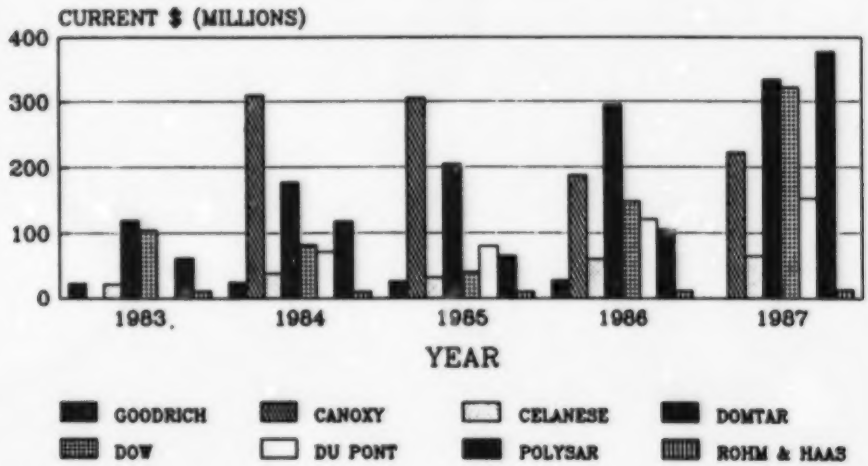
NET INCOME (LOSS)
OCM SECTOR
1983 - 1987



SOURCE: COMPANY FINANCIAL STATISTICS

Figure 10

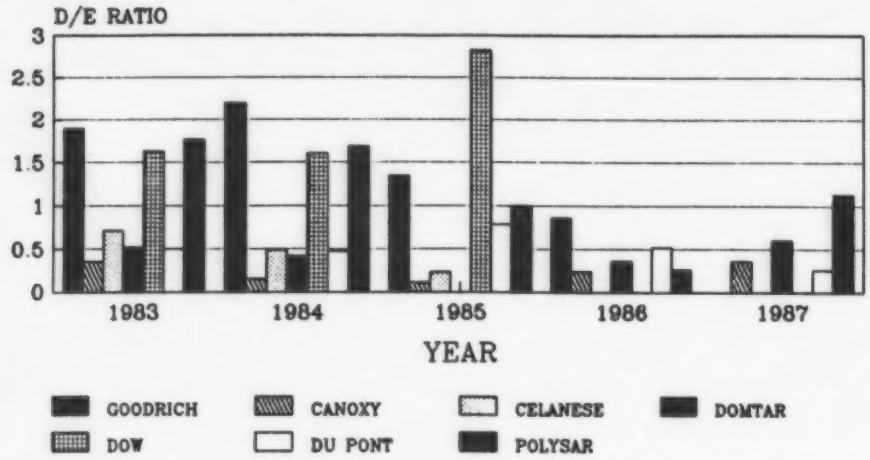
INTERNAL CASH FLOW
OCM SECTOR
1983 - 1987



SOURCE: COMPANY FINANCIAL STATISTICS

Figure 11

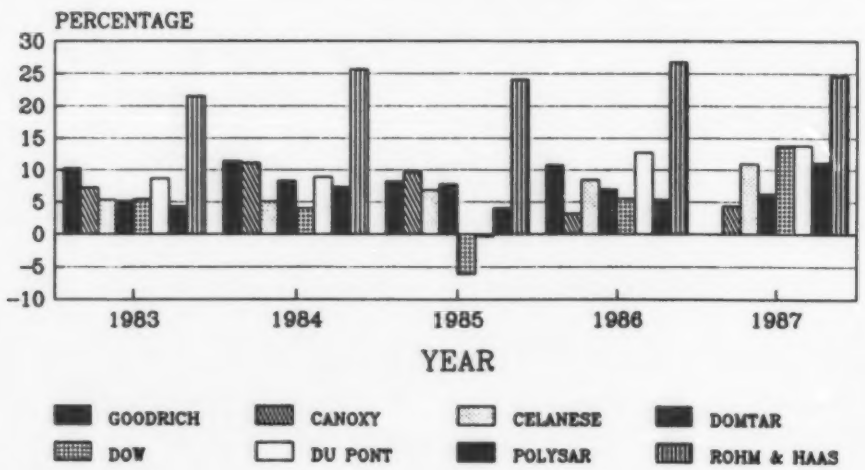
DEBT/EQUITY RATIO
OCM SECTOR
1983 - 1987



SOURCE: COMPANY FINANCIAL STATISTICS

Figure 12

RETURN ON TOTAL ASSETS
OCM SECTOR
1983 - 1987



SOURCE: COMPANY FINANCIAL STATISTICS

6.0 ENVIRONMENTAL STATUS

Tables 5a and 5b summarize the environmental compliance records of the MISA-subject plants for 1986 and 1987. Data are available for 16 of the 19 plants subject to MISA requirements.

In 1986, seven plants were in 100% compliance with Ministry plant-specific guidelines or requirements. Four plants (B.F. Goodrich, Borg-Warner, CanadianOxy, Novacor) were taking action to institute controls. In addition, BTL was reviewing its flow measurement and sampling procedures.

In 1987, the total compliance record was as follows:

Annual 1987 Compliance Record	Number of Plants
<50%	0
50% - 59%	1
60% - 69%	0
70% - 79%	3
80% - 89%	2
90% - 99%	2
100%	7

Five plants (B.F. Goodrich, Borg-Warner, CanadianOxy, DuPont-Corunna, Novacor) have or are again planning to institute appropriate controls. Courtaulds will be subject to revised requirements through a proposed Control Order which is pending the Ministry's review of Courtaulds' claim that it cannot afford to comply.

Overall, these organic chemical manufacturing sector firms in Ontario have met or are striving to meet Ontario's environmental objectives for the small number of parameters that are currently monitored regularly. The MISA program will set plant and pipe-specific discharge limits for a wide variety of other contaminants. The MISA monitoring Regulation which will be promulgated first will generate the data needed to determine what limits should be applied to each plant.

TABLE 5a

1986 ENVIRONMENTAL COMPLIANCE SUMMARY

COMPANY	PLANT LOCATION	IN COMPLIANCE		NOT IN COMPLIANCE
		MONTHLY	ANNUAL	PARAMETERS IN EXCEEDANCE OF MINISTRY GUIDELINES OR REQUIREMENTS (NUMBER OF MONTHS EXCEEDED)
B.F. Goodrich Canada Inc.	Thorold			BOD (8), TSS (4), Phosphorus (1), NH4-N (1)
BTL Industries Inc.	Belleville		YES	Phenols (4)
Borg-Warner (Canada) Limited	Cobourg			BOD (1, TSS (7), Phosphorus (10), COD (1)
CanadianOxy Chemicals Ltd.	Fort Erie			Phenols (6)
Celanese Canada Inc.	Kingston			BOD (8), TSS (3), COD (8)
Cornwall Chemicals Limited	Cornwall	(N/A)		
Courtaulds Fibres Canada	Cornwall			BOD (12), Acidity (1)
Courtaulds Films	Cornwall			BOD (12), Acidity (1)
Domtar Inc.	Longford Mills	YES	YES	
Dow Chemical Canada Inc.	Sarnia	YES	YES	
DuPont Canada Inc.	Corunna	YES	YES	
DuPont Canada Inc.	Kingston	YES	YES	
DuPont Canada Inc.	Maitland		YES	TSS (2)
Esso Chemicals Canada	Sarnia	YES	YES	
Ethyl Canada Inc.	Corunna	YES	YES	
Novacor Chemicals Ltd.*	Mooretown			TSS (4)
Polysar Limited	Sarnia	YES	YES	
Rohm and Haas Canada Inc.	Morrisburg	(N/A)		
Uniroyal Chemicals Limited	Elmira	(N/A)		

Source: MOE, Report on the 1986 Industrial Direct Discharges in Ontario, October 1987.

N/A: Data not available.
* Plant owned by Union Carbide Canada Inc. in 1986.

Legend: BOD = Biochemical Oxygen Demand
TSS = Total Suspended Solids
NH4-N = Amonia-Nitrogen
COD = Chemical Oxygen Demand

TABLE 5b

1987 ENVIRONMENTAL COMPLIANCE SUMMARY

COMPANY	PLANT LOCATION	IN COMPLIANCE		NOT IN COMPLIANCE
		MONTHLY	ANNUAL	PARAMETERS IN EXCEEDANCE OF MINISTRY GUIDELINES OR REQUIREMENTS (NUMBER OF MONTHS EXCEEDED)
B.F. Goodrich Canada Inc.	Thorold		YES	RSP (2), BOD5 (1)
BTL Industries Inc.	Belleville			PHNOL (6)
Borg-Warner (Canada) Limited	Cobourg			PPUT (4), RSP (7)
CanadianOxy Chemicals Ltd.	Fort Erie			PHNOL (9)
Celanese Canada Inc.	Kingston		YES	BOD5 (1)
Cornwall Chemicals Limited	Cornwall	(N/A)		
Courtaulds Fibres Canada	Cornwall			BOD5 (12)
Courtaulds Films	Cornwall			BOD5 (12)
Domtar Inc.	Longford Mills	YES	YES	
Dow Chemical Canada Inc.	Sarnia	YES	YES	
DuPont Canada Inc.	Corunna		YES	PHNOL (2)
DuPont Canada Inc.	Kingston	YES	YES	
DuPont Canada Inc.	Maitland	YES	YES	
Esso Chemicals Canada	Sarnia	YES	YES	
Ethyl Canada Inc.	Corunna	YES	YES	
Novacor Chemicals Ltd.	Mooretown			RSP (10)
Polysar Limited	Sarnia	YES	YES	
Rohm and Haas Canada Inc.	Morrisburg	(N/A)		
Uniroyal Chemicals Limited	Elmira	(N/A)		

Source: MOE, Report on the 1987 Industrial Direct Discharges in Ontario, October 1988.

N/A: Data not available.

Legend: BOD5 = Biochemical Oxygen Demand (5 day)
RSP = Residue Particulate (total suspended solids)
PHNOL = Phenols
PPUT = Phosphorus (unfiltered total)

7.0 CONCLUSIONS

The organic chemical manufacturing sector is characterized by a capital intensive infrastructure, which impedes entry and exit and makes market adjustments to supply and demand pressures difficult to achieve in the short run. The sector health is closely linked to the business cycle, which is now at a peak. As a result, sector firms are experiencing profits and are recovering from the recession of the early 1980's. Relatively lower feedstock prices, tight capacity in the petrochemical sector, high demand and a weak Canadian dollar are all working to boost Canadian, and in particular Ontario, organic chemical manufacturing sector performance statistics.

The ability of the MISA-defined OCM sector plants to deal with the costs of MISA requirements will be influenced by the economic viability of the particular operations or business sub-units that are affected. The nature of the market also makes it difficult for OCM producers to pass on local cost increases in the form of higher prices. These issues are dealt with in a separate report (see MOE, "Ontario's Organic Chemical Manufacturing Sector - Monitoring Cost Estimates", 1988).

The Canada-U.S. Free Trade Agreement, and rising world competition may impact this sector, but the implications of these trends for individual plants are not yet known.

Organic chemical plants under the MISA monitoring program have exhibited basic compliance with provincial objectives for the relatively few contaminants that are now being monitored. As the MISA program evolves, the Ministry will set limits on a much wider variety of chemical contaminants.

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